

**UNITED STATES PATENT APPLICATION
FOR GRANT OF LETTERS PATENT**

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**CONNECTOR FOR CONNECTING TWO
BUILDING MEMBERS TOGETHER
THAT PERMITS RELATIVE
MOVEMENT BETWEEN THE BUILDING
MEMBERS**

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CONNECTOR FOR CONNECTING TWO BUILDING MEMBERS TOGETHER THAT PERMITS RELATIVE MOVEMENT BETWEEN THE BUILDING MEMBERS

FIELD OF THE INVENTION

The present invention relates to light steel framing and more particularly, to a connector for connecting two structural members together in a manner that will allow one of the members to move relative to the other member while still being connected via the connector.

BACKGROUND OF THE INVENTION

Seismic activity plagues buildings and their inhabitants in many areas of the world, causing untold amounts of damage and monetary loss in addition to injury and loss of life. Building damage is mainly due to the vibration of a building which causes shifts of one portion of the building frame with respect to another portion. In conventional construction, the building components are rigidly locked together and their connective joints will fracture under the vibrational stress, often resulting in collapse.

United States Patents No. 5,467,566 for a Curtain Wall Clip; No. 5,876,006 for a Stud Mounting Clip; and No. 5,906,080 for a Bracket For Interconnecting A Building Stud To Primary Structural Components each provide connective building components which permit relative movement between structural members in a vertical direction. The teachings of each of these patents are incorporated by reference. These patents all recognize an important need to permit building frame members to shift rather than fracture. However, none of these patents provides for movement in a horizontal plane, although this movement does occur during an earthquake. Thus, while the building floor is free to move relative to its walls for a limited vertical distance when the known connectors are used, horizontal movement is not an option. When the seismic vibration occurs in a direction to induce horizontal shift, damage, injury, and death can still happen.

SUMMARY OF THE INVENTION

The present invention entails a connector for connecting building components in a manner that permits bi-directional relative movement between the building components. In one embodiment, the connector includes first and second plates disposed at an angle with respect to each other. Each plate includes a pair of flanges disposed on opposite sides thereof. At least one elongated slot is formed in each plate and wherein the slot in one plate is oriented at an angle with respect to the slot in the other plate. Finally, a pair of spaced-apart reinforcing straps extend between the first and second plates.

In one particular embodiment, the reinforcing straps are secured between corresponding pairs of flange formed about the plates of the connector. In this embodiment, the plates are further secured together by fasteners wherein each fastener connects one flange of one plate with one flange of the other plate.

In another embodiment, the present invention entails a connector for interconnecting two building members wherein the connector includes a track and a slideable connecting member confined within the track. In this case, the connecting member includes a portion that projects from the track and functions to attach to one of the building members via one or more fasteners that extend through one or more slots in the portion. The track, on the other hand, connects to the other building member. Consequently, the connecting member can move within the track in response to one of the building members moving relative to the other building member. Further, because of the one or more slots in the portion of the connecting member extending from the track, there can be relative movement between the other building member and the portion of the connecting member extending from the track.

Other objects and advantages of the present invention will become apparent and obvious from a study of the following description and the accompanying drawings which are merely illustrative of such invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In order for the invention to become more clearly understood it will be disclosed in greater detail with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a first embodiment of the invention connector installed to connect between a vertical wall stud and a horizontal wall-top track so as to allow bi-directional deflection between the structural components illustrated.

Figure 2 is an enlarged cross sectional view through the connector of Figure 1 taken in the direction of line 2 - 2 of Figure 1 with fasteners shown in position prior to their installation.

Figure 3 is a perspective view of a second embodiment of the invention connector in which vertical mounting slots and horizontal mounting slots are offset from one another.

Figure 4 is a perspective view of a third embodiment of the invention connector in which vertical mounting slots and horizontal mounting slots are differently oriented.

Figure 5 is a perspective view of a fourth embodiment of the invention connector employing three parallel slots on each connector plate.

Figure 6 is a perspective view of a fifth embodiment of the invention connector employing a rectangular stepped mounting plate on one connector plate and three slots on the other connector plate.

Figure 7 is an enlarged cross sectional view through the connector of Figure 6 taken in the direction of line 7 - 7 of Figure 6.

Figure 8 is a schematic diagram illustrating three mutually orthogonal axes.

Figure 9 is a perspective view of another embodiment of the invention in which a plurality of uni-directional brackets are assembled to a track that is free to move in a direction perpendicular thereto.

Figure 10 is a perspective view of a uni-directional bracket of Figure 9 prior to assembly thereto.

Figure 11 is an exploded perspective view of another connector design.

Figure 12 is a perspective view of the design shown in Figure 11.

Figure 13 is a fragmentary perspective view illustrating the connector of Figures 11 and 12 secured to two building members.

Figure 14 is a perspective view of yet another connector design showing the connector connected to two building members.

Figure 15 is a cross-sectional view taken through the line 5-5 of Figure 14.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Figure 1 shows a first embodiment of the invention connector **10** as it is mounted to slidably connect vertical member **30** to intersecting horizontal member **32**. Vertical member **30** is, for example, a metallic wall stud, and horizontal member **32** is, for example, a metallic ceiling track. Connector **10** is formed from a planar metallic sheet that has been bent to form vertical plate **12** and horizontal plate **14** being connected to each other in substantially perpendicular relation at juncture **16**. Connector **10** is preferably formed of galvanized sheet steel by punching and bending operations, as are known.

Vertical plate **12** is formed with a pair of vertical slots **20**. Horizontal plate **14** is formed with a pair of parallel horizontal slots **26**. Variations, such as forming one or both of vertical plate **12** and horizontal plate **14** with stiffening ribs or flanges, or punching a differing number of slots in each plate, are possible within the scope of the present invention.

Each of vertical plate **12** and horizontal plate **14** is slidably connected to respective vertical member **30** and horizontal member **32** by means of fasteners **22** and stepped washers **24**. Stepped washers **24**, as described in prior patents '080 and '566 noted above, are positioned into respective slots **20** and **26** and fasteners **22** are installed therethrough. Stepped washers **24** are sized to allow relative sliding motion between vertical member **30** and horizontal member **32** both in vertical direction V and in horizontal direction H. As illustrated, fasteners **22**

are preferably installed near the midpoints of slots **20** and **26** to allow for sliding vertical freedom toward each end of the respective slots.

A horizontally disposed member **34** is mounted on a series of supports, of which horizontal track member **32** is an example. If the building structure illustrated is to have additional floors, member **34** is considered a floor member. Alternatively, member **34** represents a roof member.

As will be understood by those skilled in the trade, each plate could be formed **10** with only a single slot, providing the slot were sufficiently long to permit at least two fasteners so as to maintain linear sliding motion.

Referring now to Figure 2, a cross sectional view of connector **10** is illustrated as taken in the direction of line 2 - 2 of Figure 1. This section is taken along a line through vertical slot **20** and horizontal slot **26** for clarity. Connector **10** is shown with its vertical plate **12** being in contact with vertical stud **30** and with its horizontal plate **14** in contact with horizontal track **32**.

As will be understood by those skilled in the art, in order for relative deflection to take place, fasteners securing connector **10** to building members **30** and **32** must not make binding contact with connector **10**. In one such embodiment, screw **22** is passed through stepped washer **24** to firmly engage stud **30** as described above. Stepped washer **24** has shank **23** that is smaller in diameter than the width of slot **20** and greater in height S than the thickness T of connector **10**. Flange **25** of stepped washer **24** is made of any convenient size that will not enter slot **20**. When fastener **22**, in this case a sheet metal screw, is inserted through stepped washer **24** and shank **23** thereof is positioned in slot **20**, stud **30** is able to move vertically relative to connector **10** and track **32** in the direction of arrow V .

An alternate means of fastening connector **10** is illustrated in relation to track **32**. Shoulder screw **36** essentially incorporates a sheet metal screw and a stepped washer in a single unit. Shoulder screw **36** has shoulder portion **37** that is sized and shaped similarly to shank **23** of stepped washer **24**. When shoulder screw **36** is installed through slot **26**, shoulder

portion **37** resides slidingly within slot **26** so that track **32** can move horizontally relative to connector **10** and stud **30** in the direction of arrow H.

Installation of connector **10** with a separate screw **22** and stepped washer **24** or as a single unit shoulder screw **36** can be alternatively implemented employing a rivet, a straight threaded machine screw, or other fastening means, all being within the scope of the invention.

Referring now to Figure 3, showing a further embodiment of the invention that pertains to situations in which the vertical and horizontal building members do not intersect. Connector **40** is attached to vertical member **60**, such as a stud, and to horizontal member **62**, such as a girder. Connector **40** comprises vertical plate **42** that connects to horizontal plate **44** at juncture **46**. For purposes of explanation, a line A is shown as the approximate center of connector **40**. Vertical slots **50**, formed through vertical plate **42** are positioned on a first side of line A and horizontal slots **56** are positioned on a second side of line A. In this arrangement, slots **50** and slots **56** are each positioned adjacent a respective building members **60**, **62**. Fasteners **52** are installed through each slot **50**, **56** of connector **40** with a stepped washer as described above. Alternatively, a shoulder fastener, also described above, may be used. Vertical member **60** is able to move vertically relative to horizontal member **62** in the direction of arrow V, and horizontal member **62** is able to move horizontally relative to vertical member **60** in the direction of arrow H.

Figure 4 depicts a further embodiment of the invention. Connector **70** comprises vertical plate **72**, having vertical slots **76** and horizontal plate **74**, having horizontal slots **78**. Whereas both sets of slots of the embodiments shown in Figures 1 - 3 were oriented substantially perpendicular to the juncture between the vertical and horizontal plates of the respective connector, in the embodiment of Figure 4, horizontal slots **78** are oriented parallel to junction **77**. By this variation, the relative motion between attached vertical and horizontal building components, as described in terms of a conventional three-dimensional orthogonal coordinate

system X-Y-Z (seen in Figure 8), can be oriented in an X-Y relation in one case or in a Y-Z relation in another.

Referring now to Figure 5, connector **80** provides additional modifications of the basic principle of the invention. Connector **80** has vertical plate **82** attached in perpendicular relation at juncture **83** to horizontal plate **84**, and flanges **92** and **92'** extending perpendicularly from the lateral edges of the respective plates **82** and **84**. Vertical plate **82** is formed with, for example, three vertical slots **88** therethrough. Horizontal plate **84** is formed with, for example, three horizontal slots **90** that are oriented substantially parallel to juncture **83**. As will be apparent to those skilled in the art, the decision of how many parallel slots are to be formed in each plate is somewhat arbitrary, as evidenced by the examples shown herein containing two slots in one case and three slots in another. Thus, the number of slots shown is an example of selected embodiments of the invention and not a limitation of its scope.

A further embodiment of the invention is illustrated in Figures 6 and 7. Figure 6 shows connector **100**, having first vertical plate **102** attached perpendicularly at juncture **103** to second vertical plate **104**. Connector **100** is adapted for installation in situations where vertical member **120**, e.g., a stud, is being attached slideably to horizontal member **122**, e.g., an angle beam, and the building members do not intersect. However, the connector shown in this embodiment could be utilized to slidably attach intersecting structural members as shown in Figure 1. Vertical plate **102** is formed with three vertical slots **106** that are substantially parallel to juncture **103**, each slot **106** having a fastener and stepped washer installed therethrough as described above. Vertical plate **104** is formed with an elongate slot in the form of a rectangular window **112**. Window **112** is oriented with its long dimension horizontal. A guide **114**, best seen in Figure 7, is bent so as to have an engaging surface E adapted for engaging angle beam **122** and a retaining surface R parallel to and offset from engaging surface E, and adapted for containing vertical plate **104** in sliding engagement with angle beam **122**. The offset distance D (see Figure 7) between surfaces E and R of guide **114** is slightly greater than the thickness of

the metal from which vertical plate **104** is made. Figure 7 provides a cross section of guide **114** to show the required depth of offset between the engaging and retaining the two levels of guide **114**. The engaging surface of guide **114** is slightly narrower than the opening of window **112** to permit sliding. Thus this further embodiment provides an additional manner of achieving vertical deflection of a first building structural member in the direction of arrow V and horizontal deflection of a second building structural member in the direction of arrow H (Figure 6).

Referring now to Figure 9, a second embodiment of the invention is illustrated. This second embodiment provides a track **132** to which a plurality of brackets **140** have been assembled for connecting a plurality of studs **130** to a ceiling member **134** or a floor member (not shown). Track **132** is formed in a generally elongate channel shape with a series of linear slots **136** punched through web **132w** thereof at selected intervals along track **132**. Typical intervals from the center of a first slot **136** to the center of an adjacent slot **136** is either 16 inches or 24 inches to accommodate the typical spacing of studs in a building wall. Slots **136** are oriented substantially parallel to the length of track **132**.

The second component of the second embodiment of the invention is bracket **140**, formed of bent metal to have vertical plate **142** and horizontal plate **144**, seen prior to assembly to track **132** in Figure 10. Vertical plate **142** is preferably formed with a pair of parallel, vertically oriented slots **148** therethrough. Horizontal plate **144** is preferably formed without holes. One uni-directional bracket **140** is fixedly mounted to web **132w** intermediate each pair of adjacent slots **136**, for example by spot welding, so as to be similarly spaced apart from the next bracket **140**. By welding brackets **140** to track **132**, as opposed to assembly with screws or rivets, no fastener part protrudes above track **132**.

With a plurality of brackets **140** welded or otherwise affixed to the inside of web **132w** and a plurality of slots **136** formed through web **132w** intermediate brackets **140**, track **132** is slidably assembled to ceiling member **134** by means of a fastener **152** passed through each slot **136**. Fastener **152** preferably comprises a sheet metal screw with a spacer, as discussed in

detail above. Track **132** will be moveable in the direction indicated by arrow H, but no other direction. With track **132** thus mounted, a series of vertically oriented studs **130** are slidably assembled to bracket **140** by passing a similar fastener **152** through slots **148** in vertical plate **142**. Studs **130** are preferably formed shorter by approximately the height d of track **132** as compared to the distance between ceiling track **132** and a floor track (not shown) to allow a degree of vertical freedom in case of seismic activity. Ceiling track **132** is slidably mounted to ceiling member **134** to allow horizontal freedom.

Figures 11 through 13 illustrate another embodiment of the present invention. Here a connector, indicated generally by the numeral **200**, is shown and as particularly illustrated in Figure 13 is adapted to be connected to two building members which in this case comprise a vertical member **230** (stud) and a horizontal member **232**. As we will appreciate from the subsequent disclosure, connector **200** enables the two building members **230** and **232** to move relative to each other while still being connecting by the connector **200**.

Viewing connector **200** in more detail and with particular reference to Figures 11 and 12, the connector **200** comprises a first plate **202** and a second plate **204**. Each plate includes a central portion **202A** or **204A**. In the embodiment illustrated in Figure 11, the plates **202** and **204** are integral or formed from one piece of material which in this case is metal. In particular, the single piece of material is shaped or bent to effectively form the two plates and the angle therebetween. A bend **234** is formed at the juncture of the plates **202** and **204**. In one typical method of construction, the connector **200** initially begins as a single piece of material that includes opposed edges that are notched intermediately between the opposed ends of the piece of material. Thereafter the piece of material is bent to form the bend **234** and the outer edges are turned to form the flanges **206**. Although in the embodiment illustrated herein the plates **202** and **204** are formed from a single piece of material, it should be appreciated that the two plates **202** and **204** could be fabricated from two or more pieces of material.

Strength and rigidity is imparted to the connector **200** by flanges **206**. Each plate **202** and **204** includes a pair of opposed flanges **206**. In this case, the flanges **206** are integral or formed from the same piece of material that forms the respective plates **202** and **204**. Thus, each plate including the central portion **202A** or **204A** along with the flanges **206** form a generally U-shaped channel structure.

Formed in each plate **202** and **204** is a pair of elongated slots **208**. Note that the slots in each plate are formed such that they extend in different directions. That is, as viewed in Figure 11 for example, the slots **208** in plate **206** extend generally horizontal while the slots **208** in plate **204** extend generally vertically. A pair of fasteners **210** are extended through the end portions of the respective flanges **206**, as illustrated in Figure 11. Various types of fasteners may be used. In the embodiment illustrated herein, the fasteners **210** comprise a rivet-type fastener. As illustrated in Figure 11, the plates **202** and **204** are disposed at an angle with respect to each other. In the particular embodiment illustrated herein, plates **202** and **204** form a generally 90° angle. Other angles may be formed between the plates. This facilitates the securement of the connector **200** to a horizontal building member and a vertical building member as illustrated in Figure 13. Fasteners **210** are secured adjacent the juncture area or bend **234** of the two plates **202** and **204**.

Extending diagonally across opposed portions of the connector **200** is a pair of reinforcing strip **212**. Note in Figures 11 and 12 that each reinforcing strip **212** extends outwardly of a pair of flanges **206**. In the case of the embodiment illustrated in Figures 11-13, each strap **212** extends from the end of plate **204** to an intermediate point on plate **202** with the reinforcing strap connected to the respective flanges **206** of these plates. A series of fasteners **214** are utilized to secure the straps **212** to the flanges **206**. Various fasteners can be used. In the embodiment illustrated herein the fasteners **214** are of the rivet-type.

To provide additional strength and rigidity to the connector **200**, a reinforcing member **216** can be utilized with each plate **202** and **204**. In this case, the reinforcing member **216**

assumes a generally U-shaped or channel-shaped metal bar and includes a pair of openings spaced to align where the slots **208** formed in either plate **202** or **204**. Each reinforcing member **216** is designed to be secured to the outer face of the plates **202** and **204**. Stepped washers **218** of the type discussed above and particularly shown in Figure 2 can be utilized in securing the connector **200** to the stud **30** and horizontal building member **232**, as shown in Figure 13. The stepped washers **218** are inserted through the openings in the reinforcing members **216** such that a portion of the stepped washers extend into and through the respective slots **208**. Thereafter, conventional metal fasteners screws **220** are inserted into the stepped washers **218** and into the respective building members **230** and **232**.

As noted above, Figure 13 illustrates the connector **200** secured to both a vertical building member which in this case is a stud **230** and a horizontal building member **232**. Either building member **230** or **232** may move with respect to the other without breaking or fracturing the joint formed by the connector **200**. In the case of relative movement, the reinforcing member **216** and the associated fasteners **220** can move back and forth relative to the adjacent plate **202** or **204**.

Turning to Figures 14 and 15, another embodiment for a connector that permits bi-directional movement for building members is shown. In this case, the connector is indicated generally by the numeral **250**. Connector **250** includes an elongated track **252**. In this case, the elongated track **252** is generally of a C-shape and includes a back **252A** and an edge **252B**. Note in Figure 15 where the edge **252B** extends along one edge of the track **252** and curls over so as to define a track interiorly of the back **252A** and the edge **252B**. Track **252** is adapted to be fixably secured to a building member. In this case, track **252** is secured to horizontal building member **252**.

Slideably mounted or contained within track **252** is a connecting member indicated generally by the numeral **254**. Connecting member **254** in this embodiment includes a first portion **256** and a second portion **258**. The first portion **256** is contained within the elongated

track **252** and slidable back and forth therein. That is, as illustrated in Figure 15, the first portion **256** of the connecting member **254** is disposed such that it lies adjacent the back **252A** of the elongated track and the outer edges **252B** of the track **252** curl around and confines the first portion **256** within the elongated track.

The second portion **258** of connecting member **254** extends outwardly from the track **252**. This is illustrated in both Figures 14 and 15. That is, the second portion **258** is oriented at an angle with respect to the first portion of **256**. In this case, the second portion is disposed generally at an angle of approximately 90° with respect to the first portion **256**. As illustrated in the drawings, the first portion **256** is provided with a series of vertical ribs **260** that reinforce the same. The second portion **258** includes a pair of flanges **258A**. The flanges **258A** are turned to form a 90° angle with the central area of the second portion **258**.

A series of slots **270** are formed in the second portion **258**. Various means can be utilized to secure the second portion **258** to a building member such as the stud **230** shown in Figures 14 and 15. In the embodiment illustrated in Figures 14 and 15, the reinforcing member **216** discussed above with respect to the embodiment of Figures 11-13 is shown incorporated into this embodiment. However, it should be appreciated that the same type of securing arrangements discussed above with respect to the various embodiments disclosed herein can be utilized for securing the second portion **258** to the stud **230**.

In this embodiment, the first and second portions **256** and **258** of the connecting member **254** are of an integral construction, that is, they are formed from a single piece of metal. An example of the construction of the connecting member **254** would entail cutting opposing slots from opposite edges of the connecting member **254** about the bend or juncture area. Thereafter, the connecting member **254** would be bent such that a selected angle is formed between the first and second portions **256** and **258**. Thereafter, the flanges **258a** would be formed by simply bending them to the position that they occupy in Figures 14 and 15. Of

course, it is appreciated that other procedures can followed to form or fabricate the connecting member **254**. That is, the connecting member **254** could comprise a multi-piece member.

As illustrated in Figure 14, the elongated track **252** can accommodate a series of spaced-apart connecting members **254**. The connecting member **254** would be spaced such that they can move back and forth within the elongated track **252**. Consequently, it is appreciated that the entire connecting member **254** can move back and forth within the elongated track **252** in response to certain loads or forces being applied to the building structure. In addition, there can be relative movement between the second portion **258** of the connecting member **254** and the adjacent building member **230**.

The present invention may, of course, be carried out in other specific ways than those herein set forth without departing from the scope and the essential characteristics of the invention. The present embodiments are therefore to be construed in all aspects as illustrative and not restrictive and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.